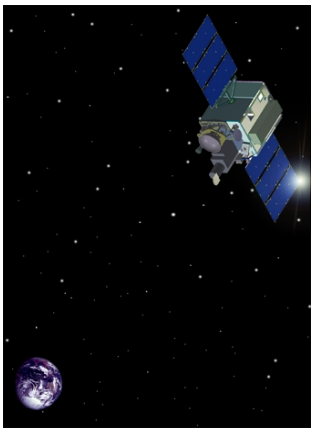
Cryogenic Communications Satellite (CryoCommSat)



The Naval Research Laboratory is developing a cryogenic communications payload system CryoCommSat which would function as an on-orbit operational test and evaluation platform for cryogenic communications systems. This advanced technology demonstration would operate primarily in the Ka-band and would address communications satellite requirements pertaining to commercial, NASA, and DoD applications. The CryoCommSat payload is tentatively manifested on the Indian Ocean Meteorological Instrument (IOMI) satellite and would operate in a "bent pipe" transponder mode.

The goals of this project are to demonstrate performance enhancements in data rate transmission characteristics or reduced size for both ground and orbital equipment at the given data rate. This would be achieved by employing cryogenic and superconducting technologies that can provide:

a) better bandwidth utilization through reduction of guard band requirements
b) increased selectivity per channel resulting in improved adjacent channel isolation
c) decreased ground antenna sizes resulting from lower receiver noise figures.

The plans are to configure the CryoCommSat payload to address high data link requirements for future generation commercial, NASA and DoD missions. The IOMI host satellite is scheduled for launch in early FY05 (November 2004) into geo-stationary orbit over the United States. It will stay in this location for 18-24 months and then be moved to the Indian Ocean area for another 3-5 years of operations. This planned schedule will provide ample opportunities to test and evaluate the CryoCommSat system under operational conditions.

The CryoCommSat concept addresses several issues for both the spacecraft and ground site systems with the goal of increasing data throughput. The spacecraft payload would include:

a) a cryogenically cooled input filter and Low Noise Amplifier (LNA), which would lower the noise temperature of the receiver and efficiently reject out of band interfering signals
b) a local oscillator and mixer, possibly cryogenic, to convert the input signal to some intermediate frequency (IF)
c) a cryogenic input demultiplexer and a cryogenic output multiplexer operating at the IF
d) ambient temperature high power amplifier(s) (HPAs) for downlink.

In addition to the space-based systems, ground based terminals for high data rate transmission will also be evaluated. A cryogenic K-band ground terminal system, based on one built by NASA to support development of the 622 MB/s Direct Data Distribution (D^3) project, would be developed and tested. The NASA results suggest that the size of the ground station reflector can be decreased from 1.8 m for the conventional system to 0.9 m for a cryogenic system while maintaining the desired data throughputs.

Additional concepts under consideration for CryoCommSat include:

a) a cryogenic filter bank between the HPAs and the transmit antenna to remove spurs from the output RF signal
b) on-board processing and switching among the various input and output channels
c) on-board UHF communications relay capability to address specific DoD needs.

The CryoCommSat concept is based on results obtained from a DARPA sponsored Technology Reinvestment Program (TRP) and executed by NASA Glenn in Cleveland, Ohio, NASA sponsored R&D, and on-orbit demonstrated performance from HTSSE-II microwave devices and cryocooler systems. Under the TRP, a 60-channel input multiplexer (operating at C-band) was built, integrated with two cryocoolers (one for redundancy), and space qualified. Four of the channels were filters identical to those flown on the INTELSAT-8 commercial communication satellite. Although the other channels were not active, they represented the mass, size and cryogenic heat load for a fully populated input multiplexer. In the CryoCommSat proposal, these 60 channels would be populated and designed according to the IF filtering and channelization requirements for commercial, NASA and DoD applications.

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